

**SNS-OPM-ATT 2.B-10.a.**  
**Unreviewed Safety Issue (USI) Evaluation Form**

**I. Title of USI Evaluation:**

**USI Evaluation for Lack of HEBT Chipmunk Enabled-Ring in Power Permit Logic  
Functionality Check In PPS Certification Procedure**

**II. Description of Proposed Activity (or discovered condition) (use attachments if necessary):**

This USI Evaluation assesses the discovered condition that accelerator PPS certification procedures did not contain steps to fully test the functionality of the HEBT Chipmunk enabled/Ring in Power Permit logic. The logic functionality was tested after the discovered condition and found to be functioning properly. Testing of the logic functionality has been added to the PPS certification procedure.

**Background**

During a review of the PPS system in August 2013 it was discovered that a particular portion of the PPS logic was not being tested as part of the PPS certification procedures. Specifically, the logic branch that requires either the HEBT Chipmunk 200 to be enabled, or the Ring to be in power permit in order to allow beam to be run to the LINAC beam dump was not fully tested by the PPS Certification Procedure. Once identified, the logic was fully tested (August 2013) and found to be fully functional.

It should be noted that the HEBT Chipmunk 200 is tested annually in accordance with approved SNS procedures. The functionality of the chipmunk and chipmunk channel are certified annually by SNS Procedure OPM 2.H.18.7 *Chipmunk System Certification* which requires that the chipmunk be hooked up to the PPS system in position HEBT 200 and then the chipmunk is source tested to ensure that the PPS properly responds to radiation and to a high level radiation trip. Therefore the functionality of the channel is certified annually per procedure. What has not been checked as part of the annual PPS certification procedures is the logic gate functionality that requires either the HEBT Chipmunk 200 to be enabled, or the Ring to be in power permit in order to allow beam to be run to the LINAC beam dump. Testing of the logic functionality has been added to the PPS certification procedure.

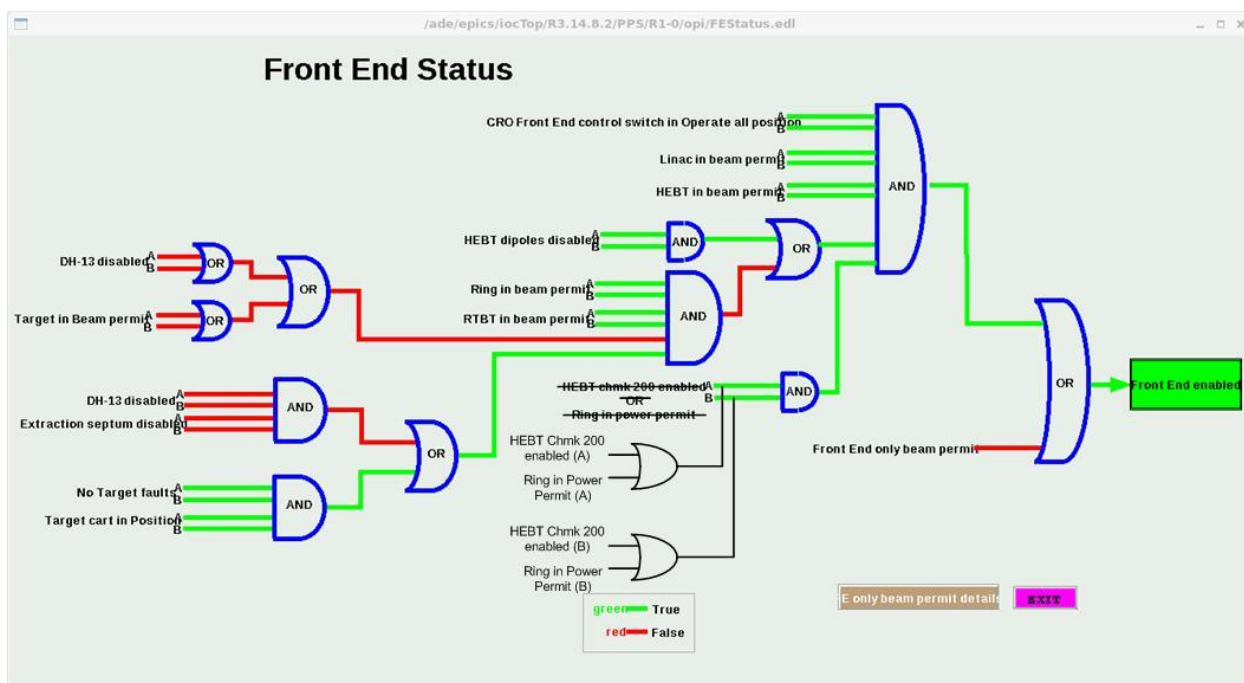
The FSAD-PF addresses the PPS and its safety functions. FSAD-PF Table 3.2.3.5-1 *Beam Containment Modes* lists several beam containment modes allowed by the PPS. The beam containment modes allow personnel to safely access downstream tunnel segments while the PPS ensures beam is safely contained upstream. In LINAC Tuning Mode, personnel are allowed in the RING and downstream areas while beam is allowed to the LINAC dump. The PPS enforces safety by controlling critical devices to ensure beam is contained within the LINAC and does not pass into the HEBT. The critical devices are the first through eighth HEBT Dipole magnets. PPS control of the HEBT Dipole magnets ensures direct beam cannot be transported out of the LINAC.

As an added measure of safety, the PPS logic also includes the use of a chipmunk radiation

detector (referred to as the HEBT 200 chipmunk) that is placed in the RING (just downstream of the shielding wall that separates the HEBT from the RING) to trip the beam upon elevated radiation levels. Therefore, in addition to controlling the required critical devices described above, the PPS system logic further requires the HEBT 200 Chipmunk to be “enabled” in order for personnel to access the RING with beam to the LINAC. If HEBT Chipmunk 200 is not enabled, the PPS requires the RING to be in Power Permit in order to run beam to the LINAC dump. This step ensures that the RING is clear of personnel by requiring a sweep and preventing access.

The logic described above can be depicted as an OR logic gate as shown in lower portion of Figure 1 below. Two OR gates are depicted showing the two redundant Channels A and B.

As can be seen from the logic diagram, in order to pass beam to the LINAC beam dump, either the HEBT 200 Chipmunk must be enabled, or the Ring must be placed in Power Permit mode ensuring all personnel are cleared from the Ring.



**Figure 1.** Depiction of the HEBT Chipmunk 200/Ring in Power Permit OR Gate Logic. (Note the redundancy of the A and B Channels.)

The purpose of the HEBT 200 Chipmunk is to trip the beam on postulated elevated radiation levels that might be possible in the unlikely event of a beam spill/miss-steer at the end of the LINAC. While no direct beam could be diverted to the HEBT or RING, it is possible that radiation emanating from a beam spill could shine down the HEBT and even thru the shield wall that separates the HEBT from the RING.

Running beam in LINAC Tuning Mode to the LINAC beam dump is limited to 7.5 kW by Section 1.3 of the ASE and limited to 7 kW by the SNS Operations Envelop. Beam spills at these low powers would not create significant dose rates in the RING.

A very unlikely scenario could be postulated where a 2 MW beam is transported during LINAC Tuning Mode, in violation of the ASE limit of 7.5 kW. It could be further possible that the full power beam spills into the first HEBT dipole (labeled as DH 11 in Figure 2) creating the maximum credible beam spill with shine that would travel down the HEBT. Radiation from such a spill would be attenuated by the shield wall that separates the HEBT from the RING. Dose rate estimates have been performed<sup>1</sup> for doses in the Ring, directly adjacent to the shield wall that separates the HEBT from the Ring that show doses in Ring would only be on the order of about 266 mrem/hr in the highly unlikely event that 2 MW beam is transported and spilled in LINAC Tuning Mode.

Dose rates on top of the earth berm above the LINAC/HEBT would be far higher than those in the Ring because the RING is out of sight of direct beam, is separated by large distance, and is shielded by the shield wall that separates the HEBT from the Ring. Such a scenario would be quickly terminated because elevated dose rates on top of the earth berm would be detected by the berm chipmunk which would perform its credited function of tripping off the beam. The neutronics dose estimate<sup>2</sup> shows that doses on top of the berm directly above the beam spill would be on the order of ~ 20 Rem/hr which far exceeds the chipmunk 100 mR/hr trip set point.

Therefore, even in the highly improbable event of a 2 MW beam spill during LINAC Tuning Mode, dose rates to individuals in the Ring would be relatively low (~ 266 mrem/hr) and would be of short duration because the chipmunk on top of the earth berm would trip on high radiation. Therefore it is concluded that the safety function of HEBT Chipmunk 200 is for ALARA purposes and is not essential to personnel safety.

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<sup>1</sup> Gallmeier, Franz, Neutronics Design Calculations for the HEBT Shield Labyrinth, SNS 106100200-TR0060-R00, December 2001.

<sup>2</sup> Gallmeier, Franz, Dose Equivalents on Top of the Accelerator Earthberm due to a Full Beam Loss in the HEBT Arc, SNS 106100200-TR0061-R00, December 2001.

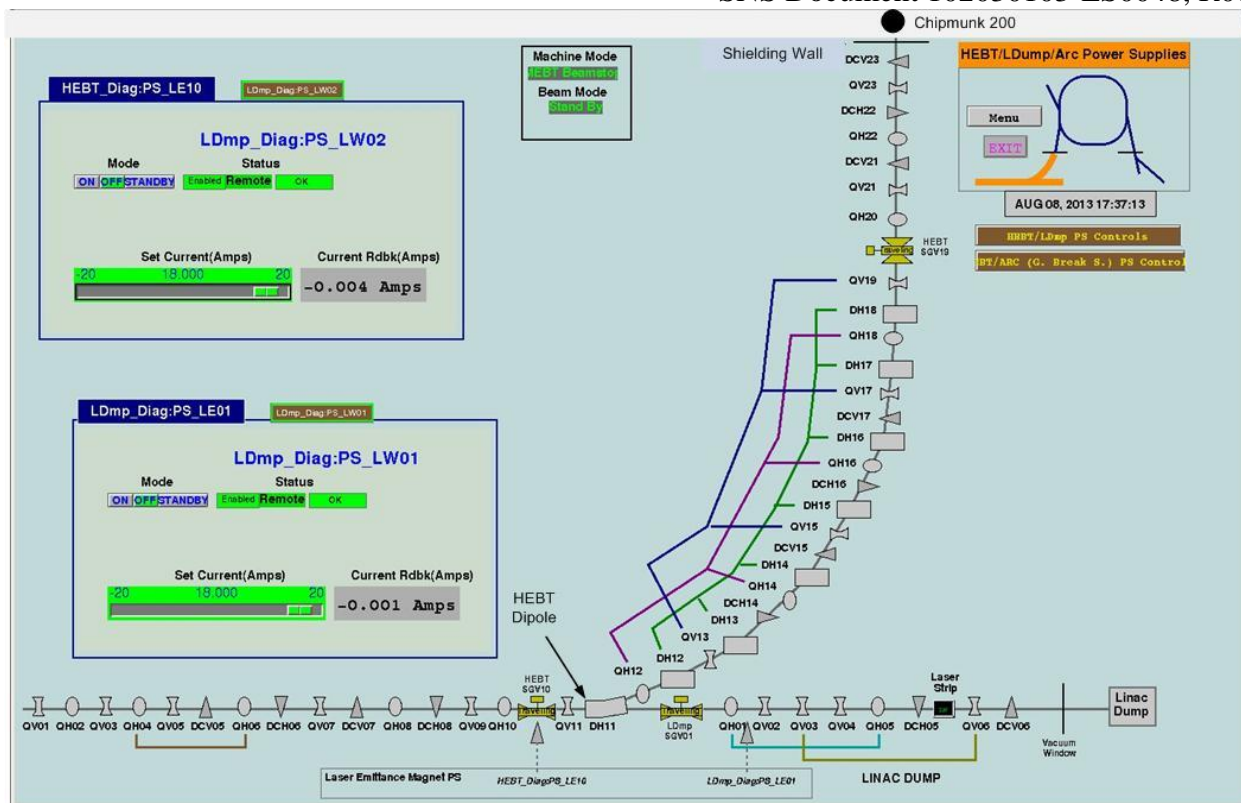


Figure 2. Depiction of LINAC and HEBT components.

**III. Does the proposed activity or discovered condition affect information presented in the FSAD-NF or FSAD-PF, e.g. regarding equipment, administrative controls, or safety analyses. If so specify the applicable FSAD and relevant sections.**

The PPS system and its architecture are described in both the FSAD-PF and FSAD-NF. Section 5.2.1.5 of the FSAD-PF requires annual certification in accordance with SNS Procedures to ensure reliability of the PPS. Details regarding individual steps of the certification procedure are not addressed. No changes to the FSADs are warranted based on this evaluation.

**IV. Does the proposed activity or discovered condition affect any of the requirements of the ASE. If so, list the affected sections**

The ASE addresses the PPS system in Section 3.2. Section 3.2.3 of the ASE requires the PPS to undergo annual certification as specified by approved SNS procedures. Details regarding individual steps of the certification procedure are not addressed. No changes to the ASE are warranted based on this evaluation.

**V. USI Evaluation Criteria:**

1. Could the change significantly increase the probability of occurrence of an accident previously evaluated in the FSADs? Yes \_\_\_ No\_x\_

**Justification:** PPS is a Credited Engineered Control (CEC) whose primary function is to protect workers from potentially injurious prompt radiation produced by accelerator operations. The unmitigated probability of occurrence of these accidents is unaffected by the operability of the HEBT Chipmunk 200.

2. Could the change significantly increase the consequences of an accident previously evaluated in the FSADs?    Yes\_\_ No x

**Justification:** The PPS is a CEC whose primary function is to protect workers from potentially injurious prompt radiation produced by accelerator operations. The unmitigated consequences of these accidents is unaffected by the operability of the HEBT Chipmunk 200.

3. Could the change significantly increase the probability of occurrence of a malfunction of equipment important to safety previously evaluated in the FSADs?

Yes\_\_ No x

**Justification:**

The PPS is a CEC whose primary function is to protect workers from potentially injurious prompt radiation produced by accelerator operations.

The HEBT Chipmunk 200 is tested annually in accordance with approved SNS procedures. The functionality of the chipmunk and chipmunk channel are certified annually by SNS Procedure OPM 2.H.18.7 *Chipmunk System Certification* which requires that the chipmunk be hooked up to the PPS system in position HEBT 200 and then the chipmunk is source tested to ensure that the PPS properly responds to radiation and to a high level radiation trip. Therefore the functionality of the channel is certified annually per procedure. What has not been checked as part of the annual PPS certification procedures is the logic gate functionality that requires either the HEBT Chipmunk 200 to be enabled, or the Ring to be in power permit in order to allow beam to be run to the LINAC beam dump.

The analysis above shows that no significant dose potential exists, even in the event of a malfunction of the HEBT 200 Chipmunk/Ring in Power Permit logic. The functionality of the essential FSAD-required critical devices (first thru eighth dipole magnets in the HEBT) to allow personnel access to the Ring during LINAC Tuning Mode are tested by the PPS certification procedures ensuring their operability.

Testing described above as part of the PPS certification procedures ensures equipment important to safety as described in the FSAD-PF for personnel entry into the Ring (Table 3.2.3.5-1 of the FSAD-PF) is maintained operable. The probability of occurrence of a malfunction of equipment important to safety as previously evaluated in the FSAD was not significantly increased.

4. Could the change significantly increase the consequences of a malfunction of equipment important to safety previously evaluated in the FSADs?

Yes\_\_ No

**Justification:** The PPS is a CEC whose primary function is to protect workers from potentially injurious prompt radiation produced by accelerator operations. The consequences of a failure of the PPS system were unchanged by the lack of routine testing of the HEBT 200 Chipmunk/Ring in Power Permit logic. The analysis above shows that no significant dose potential exists, even in the event of a malfunction of the HEBT 200 Chipmunk/Ring in Power Permit logic. The functionality of the essential FSAD required critical devices to allow personnel access to the Ring during LINAC Tuning Mode are fully tested by the PPS certification procedure ensuring their operability. Therefore, the consequences of a malfunction of equipment important to safety as previously evaluated in the FSAD were not significantly increased.

5. Could the change create the possibility of a different type of accident than any previously evaluated in the FSADs that would have potentially significant safety consequences?

Yes\_\_ No

**Justification:** No new types of accidents were introduced by the lack of routing testing of the HEBT 200 Chipmunk/Ring in Power Permit logic during PPS certification testing. The analysis above shows that no significant dose potential exists, even in the event of a malfunction of the HEBT 200 Chipmunk/Ring in Power Permit logic. Although the functionality of the HEBT 200 Chipmunk/Ring in Power Permit logic was not being routinely tested as part of the PPS certification procedure, the logic has been tested and found to be functioning properly. The functionality of the essential FSAD required critical devices to allow personnel access to the Ring during LINAC Tuning Mode are fully tested by the PPS certification procedure ensuring their operability.

6. Could the change increase the possibility of a different type of malfunction of equipment important to safety than any previously evaluated in the FSADs?

Yes\_\_ No

**Justification:** No new types or different types of malfunctions of equipment were created by the lack of routing testing of the HEBT 200 Chipmunk/Ring in Power Permit logic during PPS certification testing. The analysis above shows that no significant dose potential exists, even in the event of a malfunction of the HEBT 200 Chipmunk/Ring in Power Permit logic. Although the functionality of the HEBT 200 Chipmunk/Ring in Power Permit logic was not being routinely tested as part of the PPS certification procedure, the logic has been tested and found to be functioning properly. The functionality of the essential FSAD required critical devices to allow personnel access to


the Ring during LINAC Tuning Mode are fully tested by the PPS certification procedure ensuring their operability.

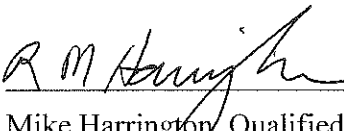
**VI. USI Determination:** A USI is determined to exist if the answer to any of the 6 questions above (Section V) is "Yes." If the answer to all 6 questions is "No", then no USI exists.

a. Does the proposed activity (or discovered condition) constitute a USI?


Yes – DOE approval required

No – Proposed activity may be implemented with appropriate internal review.

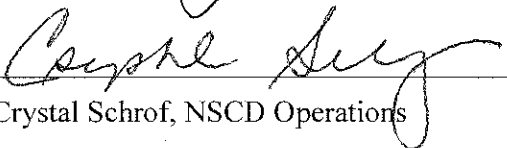
  
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